

Senator Karen Mayne proposes the following substitute bill:

STATE BUILDING CODE AMENDMENTS

2018 GENERAL SESSION

STATE OF UTAH

Chief Sponsor: Karen Mayne

House Sponsor: Mike Schultz

LONG TITLE

General Description:

This bill amends Statewide Amendments Incorporated as Part of State Construction Code.

Highlighted Provisions:

This bill:

- ▶ amends a provision of the International Building Code to provide that an individual who performs fireproof coating may obtain certain certification;
- ▶ amends a provision of the International Residential Code regarding when a drainage system is not required; and
- ▶ makes technical and conforming changes.

Money Appropriated in this Bill:

None

Other Special Clauses:

None

Utah Code Sections Affected:

AMENDS:

15A-3-104, as last amended by Laws of Utah 2016, Chapter 249

15A-3-202, as last amended by Laws of Utah 2017, Chapter 236



26

27 *Be it enacted by the Legislature of the state of Utah:*

28 Section 1. Section **15A-3-104** is amended to read:

29 **15A-3-104. Amendments to Chapters 7 through 9 of IBC.**

30 (1) In IBC, Section ~~§~~→ [703.2.3] **704.13.2** ←~~§~~, the following sentence is added to the end
30a of the section:

31 "An individual spraying fire-resistant materials may obtain a certificate that demonstrates that
32 the individual has undergone training on how to spray fire-resistant materials to manufacturer's
33 specifications."

34 [(1)] (2) IBC, Section (F)901.8, is deleted and replaced with the following: "(F)901.8
35 Pump and riser room size. Fire pump and automatic sprinkler system riser rooms shall be
36 designed with adequate space for all installed equipment necessary for the installation and to
37 provide sufficient working space around the stationary equipment. Clearances around
38 equipment shall be in accordance with manufacturer requirements and not less than the
39 following minimum elements:

40 901.8.1 A minimum clear and unobstructed distance of 12-inches shall be provided from the
41 installed equipment to the elements of permanent construction.

42 901.8.2 A minimum clear and unobstructed distance of 12-inches shall be provided between
43 all other installed equipment and appliances.

44 901.8.3 A clear and unobstructed width of 36-inches shall be provided in front of all installed
45 equipment and appliances, to allow for inspection, service, repair or replacement without
46 removing such elements of permanent construction or disabling the function of a required
47 fire-resistance-rated assembly.

48 901.8.4 Automatic sprinkler system riser rooms shall be provided with a clear and
49 unobstructed passageway to the riser room of not less than 36-inches, and openings into the
50 room shall be clear and unobstructed, with doors swinging in the outward direction from the
51 room and the opening providing a clear width of not less than 34-inches and a clear height of
52 the door opening shall not be less than 80-inches.

53 901.8.5 Fire pump rooms shall be provided with a clear and unobstructed passageway to the
54 fire pump room of not less than 72-inches, and openings into the room shall be clear,
55 unobstructed and large enough to allow for the removal of the largest piece of equipment, with
56 doors swinging in the outward direction from the room and the opening providing a clear width

57 of not less than 68-inches and a clear height of the door opening shall not be less than
58 80-inches."

59 [~~(2)~~] (3) In IBC, Section (F)903.2.2, the words "the entire floor" are deleted and
60 replaced with "a building" and the last paragraph is deleted.

61 [~~(3)~~] (4) IBC, Section (F)903.2.4, condition 2, is deleted and replaced with the
62 following: "2. A Group F-1 fire area is located more than three stories above the lowest level
63 of fire department vehicle access."

64 [~~(4)~~] (5) IBC, Section (F)903.2.7, condition 2, is deleted and replaced with the
65 following: "2. A Group M fire area is located more than three stories above the lowest level of
66 fire department vehicle access."

67 [~~(5)~~] (6) IBC, Sections (F)903.2.8, (F)903.2.8.1, (F)903.2.8.2, and (F)903.2.8.4, are
68 deleted and replaced with the following: "(F)903.2.8 Group R. An automatic sprinkler system
69 installed in accordance with Section 903.3 shall be provided throughout all buildings with a
70 Group R fire area.

71 Exceptions:

72 1. Detached one- and two-family dwellings and multiple single-family dwellings (townhouses)
73 constructed in accordance with the International Residential Code For One- and Two-Family
74 Dwellings.

75 2. Single story Group R-1 occupancies with fire areas not more than 2,000 square feet that
76 contain no installed plumbing or heating, where no cooking occurs, and constructed of Type
77 I-A, I-B, II-A, or II-B construction."

78 [~~(6)~~] (7) IBC, Sections (F)903.2.8.3 and (F)903.2.8.3.1, are renumbered to (F)903.2.8.1
79 and (F)903.2.8.1.1.

80 [~~(7)~~] (8) IBC, Section (F)903.2.8.3.2, is renumbered to (F)903.2.8.1.2 and the
81 following exception is added:

82 "Exception: Group R-4 fire areas not more than 4,500 gross square feet and not containing
83 more than 16 residents, provided the building is equipped throughout with an approved fire
84 alarm system that is interconnected and receives its primary power from the building wiring
85 and a commercial power system."

86 [~~(8)~~] (9) IBC, Section (F)903.2.8.4, is deleted.

87 [~~(9)~~] (10) IBC, Section (F)903.2.9, condition 2, is deleted and replaced with the

88 following: "2. A Group S-1 fire area is located more than three stories above the lowest level
89 of fire department vehicle access."

90 [~~(10)~~] (11) IBC, Section (F)904.12, is deleted and replaced with the following: "
91 (F)904.12 Commercial cooking systems. The automatic fire-extinguishing system for
92 commercial cooking systems shall be of a type recognized for protection of commercial
93 cooking equipment and exhaust systems. Pre-engineered automatic extinguishing systems
94 shall be tested in accordance with UL 300 and listed and labeled for the intended application.
95 The system shall be installed in accordance with this code, its listing and the manufacturer's
96 installation instructions.

97 Exception: Factory-built commercial cooking recirculating systems that are tested in
98 accordance with UL 710B and listed, labeled, and installed in accordance with Section 304.1 of
99 the International Mechanical Code."

100 [~~(11)~~] (12) IBC, Sections (F)904.12.3, (F)904.12.3.1, (F)904.12.4, and (F)904.12.4.1,
101 are deleted.

102 [~~(12)~~] (13) In IBC, Section 905, a new subsection, Section (F)905.3.9, is added as
103 follows:

104 "Open Parking Garages. Open parking garages shall be equipped with an approved
105 Class 1 manual standpipe system when fire department access is not provided for firefighting
106 operations to within 150 feet of all portions of the open parking garage as measured from the
107 approved fire department vehicle access. Class 1 manual standpipe shall be accessible
108 throughout the parking garage such that all portions of the parking structure are protected
109 within 150 feet of a hose connection."

110 [~~(13)~~] (14) In IBC, Section (F)905.8, the exception is deleted and replaced with the
111 following:

112 "Exception: Where subject to freezing and approved by the fire code official."

113 [~~(14)~~] (15) In IBC, Section (F)907.2.3 Group E, the first sentence is deleted and
114 rewritten as follows: "A manual fire alarm system that activates the occupant notification
115 system in accordance with Section (F)907.5 shall be installed, in accordance with Section
116 (F)907.6 and administrative rules made by the State Fire Prevention Board in Group E
117 occupancies."

118 [~~(15)~~] (16) IBC, Sections (F)915 through (F)915.6, are deleted and replaced with the

119 following:

120 "(F)915 Where required.

121 Group I-1, I-2, I-4, and R occupancies located in a building containing a fuel-burning appliance
122 or in a building that has an attached garage shall be equipped with single-station carbon
123 monoxide alarms. The carbon monoxide alarms shall be listed as complying with UL 2034 or
124 UL 2075 and be installed and maintained in accordance with NFPA 720 and the manufacturer's
125 instructions. An open parking garage, as defined in Chapter 2, or an enclosed parking garage,
126 ventilated in accordance with Section 404 of the International Mechanical Code, shall not be
127 considered an attached garage. A minimum of one carbon monoxide alarm shall be installed
128 on each habitable level.

129 (F)915.1 Interconnection.

130 Where more than one carbon monoxide alarm is required to be installed within Group I-1, I-2,
131 I-4, or R occupancies, the carbon monoxide alarm shall be interconnected in such a manner that
132 the activation of one alarm will activate all of the alarms. Physical interconnection of carbon
133 monoxide alarms shall not be required where listed wireless alarms are installed and all alarms
134 sound upon activation of one alarm. The alarm shall be clearly audible in all bedrooms over
135 background noise levels with all intervening doors closed.

136 (F)915.2 Power source.

137 In new construction, required carbon monoxide alarms shall receive their primary power from
138 the building wiring where such wiring is served from a commercial source and shall be
139 equipped with a battery backup. Carbon monoxide alarms with integral strobes that are not
140 equipped with a battery backup shall be connected to an emergency electrical system. Carbon
141 monoxide alarms shall emit a signal when the batteries are low. Wiring shall be permanent and
142 without a disconnecting switch other than as required for overcurrent protection.

143 Exceptions.

144 1. Carbon monoxide alarms are not required to be equipped with a battery backup where they
145 are connected to an emergency electrical system.

146 2. Hard wiring of carbon monoxide alarms in existing areas shall not be required where the
147 alterations or repairs do not result in the removal of interior wall or ceiling finishes exposing
148 the structure, unless there is an attic, crawl space, or basement available that could provide
149 access for hard wiring without the removal of interior finishes.

150 (F)915.3 Group E.

151 A carbon monoxide detection system shall be installed in new buildings that contain Group E
152 occupancies in accordance with IFC, Chapter 9, Section 915. A carbon monoxide detection
153 system shall be installed in existing buildings that contain Group E occupancies in accordance
154 with IFC, Chapter 11, Section 1103.9.

155 (F)915.3.1 Where required.

156 In Group E occupancies, a carbon monoxide detection system shall be provided where a
157 fuel-burning appliance, a fuel-burning fireplace, or a fuel-burning forced air furnace is present.

158 (F)915.3.2 Detection equipment.

159 Each carbon monoxide detection system shall be installed in accordance with NFPA 720 and
160 the manufacturer's instructions and be listed as complying with, for single station detectors, UL
161 2034 and, for system detectors, UL 2075.

162 (F)915.3.3 Locations.

163 Each carbon monoxide detection system shall be installed in the locations specified in NFPA
164 720.

165 (F)915.3.4 Combination detectors.

166 A combination carbon monoxide/smoke detector is an acceptable alternative to a carbon
167 monoxide detection system if the combination carbon monoxide/smoke detector is listed in
168 accordance with UL 2075 and UL 268.

169 (F)915.3.5 Power source.

170 Each carbon monoxide detection system shall receive primary power from the building wiring
171 if the wiring is served from a commercial source. If primary power is interrupted, each carbon
172 monoxide detection system shall receive power from a battery. Wiring shall be permanent and
173 without a disconnecting switch other than that required for overcurrent protection.

174 (F)915.3.6 Maintenance.

175 Each carbon monoxide detection system shall be maintained in accordance with NFPA 720. A
176 carbon monoxide detection system that becomes inoperable or begins to produce end of life
177 signals shall be replaced."

178 Section 2. Section **15A-3-202** is amended to read:

179 **15A-3-202. Amendments to Chapters 1 through 5 of IRC.**

180 (1) In IRC, Section R102, a new Section R102.7.2 is added as follows: "R102.7.2

181 Physical change for bedroom window egress. A structure whose egress window in an existing
182 bedroom is smaller than required by this code, and that complied with the construction code in
183 effect at the time that the bedroom was finished, is not required to undergo a physical change to
184 conform to this code if the change would compromise the structural integrity of the structure or
185 could not be completed in accordance with other applicable requirements of this code,
186 including setback and window well requirements."

187 (2) In IRC, Section 109:

188 (a) A new IRC, Section 109.1.5, is added as follows: "R109.1.5 Weather-resistant
189 exterior wall envelope inspections. An inspection shall be made of the weather-resistant
190 exterior wall envelope as required by Section R703.1 and flashings as required by Section
191 R703.8 to prevent water from entering the weather-resistive barrier."

192 (b) The remaining sections are renumbered as follows: R109.1.6 Other inspections;
193 R109.1.6.1 Fire- and smoke-resistance-rated construction inspection; R109.1.6.2 Reinforced
194 masonry, insulating concrete form (ICF) and conventionally formed concrete wall inspection;
195 and R109.1.7 Final inspection.

196 (3) IRC, Section R114.1, is deleted and replaced with the following: "R114.1 Notice to
197 owner. Upon notice from the building official that work on any building or structure is being
198 prosecuted contrary to the provisions of this code or other pertinent laws or ordinances or in an
199 unsafe and dangerous manner, such work shall be immediately stopped. The stop work order
200 shall be in writing and shall be given to the owner of the property involved, or to the owner's
201 agent or to the person doing the work; and shall state the conditions under which work will be
202 permitted to resume."

203 (4) In IRC, Section R202, the following definition is added: "CERTIFIED
204 BACKFLOW PREVENTER ASSEMBLY TESTER: A person who has shown competence to
205 test Backflow prevention assemblies to the satisfaction of the authority having jurisdiction
206 under Utah Code, Subsection 19-4-104(4)."

207 (5) In IRC, Section R202, the definition for "CONDITIONED SPACE" is modified by
208 deleting the words at the end of the sentence "being heated or cooled by any equipment or
209 appliance" and replacing them with the following: "enclosed within the building thermal
210 envelope that is directly heated or cooled, or indirectly heated or cooled by any of the following
211 means:

- 212 1. Openings directly into an adjacent conditioned space.
- 213 2. An un-insulated floor, ceiling or wall adjacent to a conditioned space.
- 214 3. Un-insulated duct, piping or other heat or cooling source within the space."

215 (6) In IRC, Section R202, the definition of "Cross Connection" is deleted and replaced
 216 with the following: "CROSS CONNECTION. Any physical connection or potential
 217 connection or arrangement between two otherwise separate piping systems, one of which
 218 contains potable water and the other either water of unknown or questionable safety or steam,
 219 gas, or chemical, whereby there exists the possibility for flow from one system to the other,
 220 with the direction of flow depending on the pressure differential between the two systems (see
 221 "Backflow, Water Distribution")."

222 (7) In IRC, Section 202, in the definition for gray water a comma is inserted after the
 223 word "washers"; the word "and" is deleted; and the following is added to the end: "and clear
 224 water wastes which have a pH of 6.0 to 9.0; are non-flammable; non-combustible; without
 225 objectionable odors; non-highly pigmented; and will not interfere with the operation of the
 226 sewer treatment facility."

227 (8) In IRC, Section R202, the definition of "Potable Water" is deleted and replaced
 228 with the following: "POTABLE WATER. Water free from impurities present in amounts
 229 sufficient to cause disease or harmful physiological effects and conforming to the Utah Code,
 230 Title 19, Chapter 4, Safe Drinking Water Act, and Title 19, Chapter 5, Water Quality Act, and
 231 the regulations of the public health authority having jurisdiction."

232 (9) IRC, Figure R301.2(5), is deleted and replaced with Table R301.2(5a) and Table
 233 R301.2(5b) as follows:

"TABLE NO. R301.2(5a)				
STATE OF UTAH - REGIONAL SNOW LOAD FACTORS				
	COUNTY	Po	S	Ao
	Beaver	43	63	6.2
	Box Elder	43	63	5.2
	Cache	50	63	4.5
	Carbon	43	63	5.2
	Daggett	43	63	6.5

242	Davis	43	63	4.5
243	Duchesne	43	63	6.5
244	Emery	43	63	6.0
245	Garfield	43	63	6.0
246	Grand	36	63	6.5
247	Iron	43	63	5.8
248	Juab	43	63	5.2
249	Kane	36	63	5.7
250	Millard	43	63	5.3
251	Morgan	57	63	4.5
252	Piute	43	63	6.2
253	Rich	57	63	4.1
254	Salt Lake	43	63	4.5
255	San Juan	43	63	6.5
256	Sanpete	43	63	5.2
257	Sevier	43	63	6.0
258	Summit	86	63	5.0
259	Tooele	43	63	4.5
260	Uintah	43	63	7.0
261	Utah	43	63	4.5
262	Wasatch	86	63	5.0
263	Washington	29	63	6.0
264	Wayne	36	63	6.5
265	Weber	43	63	4.5

266

TABLE NO. R301.2(5b)

267

REQUIRED SNOW LOADS FOR SELECTED UTAH CITIES AND TOWNS^{1,2}

268

The following jurisdictions require design snow load values that differ from the Equation in the Utah Snow Load Study.

269	County	City	Elevation	Ground Snow Load (psf)	Roof Snow Load (psf) 6
270	Carbon	Price ³	5550	43	30
		All other county locations ⁵	--	--	--
271	Davis	Fruit Heights ³	4500 - 4850	57	40
272	Emery	Green River ³	4070	36	25
273	Garfield	Panguitch ³	6600	43	30
274	Rich	Woodruff ³	6315	57	40
		Laketown ⁴	6000	57	40
		Garden City ⁵	--	--	--
		Randolph ⁴	6300	57	40
275	San Juan	Monticello ³	6820	50	35
276	Summit	Coalville ³	5600	86	60
		Kamas ⁴	6500	114	80
277	Tooele	Tooele ³	5100	43	30
278	Utah	Orem ³	4650	43	30
		Pleasant Grove ⁴	5000	43	30
		Provo ⁵	--	--	--
279	Wasatch	Heber ⁵	--	--	--
280	Washington	Leeds ³	3460	29	20
		Santa Clara ³	2850	21	15
		St. George ³	2750	21	15
		All other county locations ⁵	--	--	--
281	Wayne	Loa ³	7080	43	30
282	1The IRC requires a minimum live load -- See R301.6.				
283	2This table is informational only in that actual site elevations may vary. Table is only valid if site elevation is within 100 feet of the listed elevation. Otherwise, contact the local Building Official.				
284	3Values adopted from Table VII of the Utah Snow Load Study				

285	4Values based on site-specific study. Contact local Building Official for additional information.
286	5Contact local Building Official.
287	6Based on $C_e = 1.0$, $C_t = 1.0$ and $I_s = 1.0$ "

288 (10) IRC, Section R301.6, is deleted and replaced with the following: "R301.6 Utah
 289 Snow Loads. The snow loads specified in Table R301.2(5b) shall be used for the jurisdictions
 290 identified in that table. Otherwise, the ground snow load, P_g , to be used in the determination
 291 of design snow loads for buildings and other structures shall be determined by using the
 292 following formula: $P_g = (P_o^2 + S^2(A-A_o)^2)^{0.5}$ for A greater than A_o , and $P_g = P_o$ for A less
 293 than or equal to A_o .

294 WHERE:
 295 P_g = Ground snow load at a given elevation (psf);
 296 P_o = Base ground snow load (psf) from Table No. R301.2(5a);
 297 S = Change in ground snow load with elevation (psf/100 ft.) From Table No. R301.2(5a);
 298 A = Elevation above sea level at the site (ft./1,000);
 299 A_o = Base ground snow elevation from Table R301.2(5a) (ft./1,000).

300 The building official may round the roof snow load to the nearest 5 psf. The ground snow
 301 load, P_g , may be adjusted by the building official when a licensed engineer or architect submits
 302 data substantiating the adjustments.

303 Where the minimum roof live load in accordance with Table R301.6 is greater than the design
 304 roof snow load, such roof live load shall be used for design, however, it shall not be reduced to
 305 a load lower than the design roof snow load. Drifting need not be considered for roof snow
 306 loads less than 20 psf."

307 (11) In IRC, Section R302.5.1, the words "self-closing device" are deleted and replaced
 308 with "self-latching hardware".

309 (12) IRC, Section R302.13, is deleted.

310 (13) In IRC, Section R303.4, the number "5" is changed to "3" in the first sentence.

311 (14) IRC, Sections R311.7.4 through R311.7.5.3, are deleted and replaced with the
 312 following: "R311.7.4 Stair treads and risers. R311.7.5.1 Riser height. The maximum riser
 313 height shall be 8 inches (203 mm). The riser shall be measured vertically between leading
 314 edges of the adjacent treads. The greatest riser height within any flight of stairs shall not

315 exceed the smallest by more than 3/8 inch (9.5 mm).

316 R311.7.5.2 Tread depth. The minimum tread depth shall be 9 inches (228 mm). The tread
317 depth shall be measured horizontally between the vertical planes of the foremost projection of
318 adjacent treads and at a right angle to the tread's leading edge. The greatest tread depth within
319 any flight of stairs shall not exceed the smallest by more than 3/8 inch (9.5 mm). Winder
320 treads shall have a minimum tread depth of 10 inches (254 mm) measured as above at a point
321 12 inches (305 mm) from the side where the treads are narrower. Winder treads shall have a
322 minimum tread depth of 6 inches (152 mm) at any point. Within any flight of stairs, the
323 greatest winder tread depth at the 12-inch (305 mm) walk line shall not exceed the smallest by
324 more than 3/8 inch (9.5 mm).

325 R311.7.5.3 Profile. The radius of curvature at the leading edge of the tread shall be no greater
326 than 9/16 inch (14.3 mm). A nosing not less than 3/4 inch (19 mm) but not more than 1 1/4
327 inches (32 mm) shall be provided on stairways with solid risers. The greatest nosing projection
328 shall not exceed the smallest nosing projection by more than 3/8 inch (9.5 mm) between two
329 stories, including the nosing at the level of floors and landings. Beveling of nosing shall not
330 exceed 1/2 inch (12.7 mm). Risers shall be vertical or sloped from the underside of the leading
331 edge of the tread above at an angle not more than 30 degrees (0.51 rad) from the vertical. Open
332 risers are permitted, provided that the opening between treads does not permit the passage of a
333 4-inch diameter (102 mm) sphere.

334 Exceptions.

- 335 1. A nosing is not required where the tread depth is a minimum of 10 inches (254 mm).
336 2. The opening between adjacent treads is not limited on stairs with a total rise of 30 inches
337 (762 mm) or less."

338 (15) IRC, Section R312.2, is deleted.

339 (16) IRC, Sections R313.1 through R313.2.1, are deleted and replaced with the
340 following: "R313.1 Design and installation. When installed, automatic residential fire
341 sprinkler systems for townhouses or one- and two-family dwellings shall be designed and
342 installed in accordance with Section P2904 or NFPA 13D."

343 (17) In IRC, Section 315.3, the following words are added to the first sentence after the
344 word "installed": "on each level of the dwelling unit and".

345 (18) In IRC, Section R315.5, a new exception, 3, is added as follows:

346 "3. Hard wiring of carbon monoxide alarms in existing areas shall not be required where the
347 alterations or repairs do not result in the removal of interior wall or ceiling finishes exposing
348 the structure, unless there is an attic, crawl space or basement available which could provide
349 access for hard wiring, without the removal of interior finishes."

350 (19) A new IRC, Section R315.7, is added as follows: " R315.7 Interconnection.

351 Where more than one carbon monoxide alarm is required to be installed within an individual
352 dwelling unit in accordance with Section R315.1, the alarm devices shall be interconnected in
353 such a manner that the actuation of one alarm will activate all of the alarms in the individual
354 unit. Physical interconnection of smoke alarms shall not be required where listed wireless
355 alarms are installed and all alarms sound upon activation of one alarm.

356 Exception: Interconnection of carbon monoxide alarms in existing areas shall not be required
357 where alterations or repairs do not result in removal of interior wall or ceiling finishes exposing
358 the structure, unless there is an attic, crawl space or basement available which could provide
359 access for interconnection without the removal of interior finishes."

360 (20) In IRC, Section R403.1.6, a new Exception 3 is added as follows: " 3. When
361 anchor bolt spacing does not exceed 32 inches (813 mm) apart, anchor bolts may be placed
362 with a minimum of two bolts per plate section located not less than 4 inches (102 mm) from
363 each end of each plate section at interior bearing walls, interior braced wall lines, and at all
364 exterior walls."

365 (21) In IRC, Section R403.1.6.1, a new exception is added at the end of Item 2 and
366 Item 3 as follows: "Exception: When anchor bolt spacing does not exceed 32 inches (816 mm)
367 apart, anchor bolts may be placed with a minimum of two bolts per plate section located not
368 less than 4 inches (102 mm) from each end of each plate section at interior bearing walls,
369 interior braced wall lines, and at all exterior walls."

370 (22) In IRC, Section R404.1, a new exception is added as follows: "Exception: As an
371 alternative to complying with Sections R404.1 through R404.1.5.3, concrete and masonry
372 foundation walls may be designed in accordance with IBC Sections 1807.1.5 and 1807.1.6 as
373 amended in Section 1807.1.6.4 and Table 1807.1.6.4 under these rules."

374 (23) In IRC, Section R405.1, a new exception is added as follows: "Exception: When a
375 geotechnical report has been provided for the property, a drainage system is not required unless
376 the drainage system is required as a condition of the geotechnical report. The geological report

377 shall make a recommendation regarding a drainage system."